NON-PUBLIC?: N
ACCESSION #: 8712290071

LICENSEE EVENT REPORT (LER)

FACILITY NAME: Pilgrim Nuclear Power Station PAGE: 1 of 12

DOCKET NUMBER: 05000293

TITLE: Loss of Offsite Power
EVENT DATE: 11/12/87 LER #: 87-014-01 REPORT DATE: 12/23/87

OPERATING MODE: N POWER LEVEL: 000

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTIONS
50.73(a)(2)(iv), 50.73(a)(2)(v)

LICENSEE CONTACT FOR THIS LER:
NAME: P. J. Hamilton, Compliance Management Group Leader
TELEPHONE #: 617-747-8293

COMPONENT FAILURE DESCRIPTION:
CAUSE: B SYSTEM: JC COMPONENT: FU MANUFACTURER: N431
REPORTABLE TO NPRDS: Y
CAUSE: B SYSTEM: EK COMPONENT: II MANUFACTURER: 0000
REPORTABLE TO NPRDS: N
CAUSE: B SYSTEM: EA COMPONENT: RLY MANUFACTURER: W120
REPORTABLE TO NPRDS: N
CAUSE: X SYSTEM: LA COMPONENT: P MANUFACTURER: V125
REPORTABLE TO NPRDS: Y

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT: On November 12, 1987, at 0206 hours, a loss of preferred offsite power occurred resulting in an automatic start of the "A" and "B" Emergency Diesel Generators, a primary and secondary containment isolation signal and automatic actuation of the Reactor Protection System (full scram trip signal).

The cause of the loss of preferred offsite power was a series of storm related faults in the power transmission system remote to the Pilgrim Nuclear Power Station (PNPS). The PNPS switchyard equipment functioned as designed to isolate the station as a result of the incoming power loss. However, unanticipated equipment indications did occur which delayed power restoration until investigation and assessments were completed.

At the time of this event, the plant was in an extended outage and in a cold stable condition with fuel loaded. The secondary offsite power source was unavailable due to ongoing modification work.

The safety significance of this loss of preferred offsite power was minimal due to the automatic start of the 'A' and 'B' diesel generators. Due to the neglible core decay heat levels, reactor coolant temperatures remained stable during the temporary loss of shutdown cooling. All control rods were fully inserted and the plant remained in a cold and stable shutdown condition.

(End of Abstract)

DESCRIPTION OF EVENT

At 0206 on November 12, 1987, Pilgrim Nuclear Power Station (PNPS) experienced a loss of preferred offsite power during a severe winter storm. Plant conditions at 0001, prior to the event, were:

Mode Switch in REFUEL, with all control rods inserted.

Reactor vented via valves AO 220-46 and 47

Reactor coolant temperature less than 212 degrees F

Electrical Systems/Equipment Available:

o Startup transformer feeding plant electrical distribution system in normal outage configuration with addition of B2 tie to B4.

o 'A' and 'B' Emergency Diesel Generators (EDG) were secured and in standby.

Electrical Systems/Equipment Unavailable:

o Shutdown transformer due to the new blackout diesel - generator tie-in modifications.

o Unit auxiliary transformer partially ready for operation.
Outstanding Maintenance Requests which required Post Work Testing.

Core Cooling Standby Systems Status:

o 'A' Residual Heat Removal (RHR) pump in shutdown cooling ('C' pump secured).

o 'B', 'D' RHR pumps secured in standby.

o 'A' Core Spray secured in standby.

o 'B' Core Spray out of service due to suction valve shut for Motor Operated Valve (MOV) work.

Station Air Systems:

o K104-A, K104-C air compressors tagged out for maintenance.

o K110, K111, K104-B air compressors OPERABLE (K104-B in OFF position). The instrument air system was pressurized with the K110 air compressor in operation.

Major Evolutions in Progress:

Backwash of main condenser completed at 0030. Backwash was to clear debris as a result of storm tides. The RHR system was in use without Reactor Building Closed Cooling Water (RBCCW) flow to the heat exchangers in order to increase reactor vessel metal temperature for hydrostatic test as core decay heat was negligible.

At 0205 hours, on November 12, 1987, power transmission line No. 342 experienced a Phase A to Phase C to ground fault that resulted in switchyard Air Circuit Breaker (ACB) No. 103 and No. 104 tripping open. ACB No. 104 opened slowly. The slow operation of the breaker caused the "stuck breaker" protective logic to be actuated. This logic tripped switchyard ACB No. 105 and initiated a transfer trip sequence that tripped the breakers at the opposite end of power transmission line No. 342. At this time, switchyard ACB No. 102 was still supplying power to the start-up transformer via power transmission line No. 355 (from the Bridgewater Station).

At 0206 hours, November 12, 1987, power transmission line No. 355 experienced a Phase B to Phase C fault which tripped open the line circuit breaker at the Bridgewater Station. The Bridgewater Station breaker reclosed in 0.5 seconds which re-energized line No. 355; however, switchyard ACB No. 102 was tripped due to operation of the start-up transformer differential protection logic. The logic actuated due to a back Electro-Motive Force (EMF) from the plant motors supplied by the startup transformer combined with a degrading frequency (motor coast down) which resulted in an increasing volts-per-hertz indication to the differential protective relay. The relay functioned properly to lockout ACB No. 103 (already in trip condition) and ACB No. 102.

At 0206 hours, on November 12, 1987 all breakers in the switchyard had opened (although not simultaneously). Both emergency diesel generators started and supplied the vital busses. A primary containment isolation, a secondary containment isolation and full reactor scram signal occurred. The Nuclear Watch Engineer (NWE) dispatched an operator to the EDGs to monitor performance.

During the time interval between 0206 and 0215 hours, on November 12, 1987, power transmission line No. 355 experienced multiple phase-to-phase faults, due to high winds associated with a severe winter storm. At 0215 hours, the transmission system dispatcher ordered the breaker at the Bridgewater Station tripped and left open, isolating line No. 355, to preclude repeated breaker cycling.

The Station Manager was notified at approximately 0226. Following the resetting of the initial PCIS and RHR isolation, an additional PCIS and RHR isolation occurred when the "A" RHR pump was started. Shut down cooling was restored at approximately 0245 hours using 'A' and 'C' RHR pumps with RBCCW isolated to the heat exchangers. The 'A' control rod drive pump was secured at approximately 0246 hours to remove pressure from and prevent potential damage to the control rod drive seals. The NRC was notified at approximately 0255 hours. The Station Manager arrived on the station at 0314 and monitored evolutions in the Control Room. Electrical maintenance personnel were contacted and preparations were made to de-ice the switchyard. High winds and driving snow created hazardous conditions and made early de-icing of the switchyard ineffective. At 0555 it was determined that 4 fuses were blown in the Analog Trip System (ATS) Cabinets. This, in conjunction with RPS "B" train being unpowered, was the apparent cause of the PCIS and RHR isolation at 0230 hours. Switchyard de-icing commenced at approximately 0600. At 0630 hours, on November 12, 1987, the plant conditions were as follows:

Mode Switch REFUEL

Reactor vented via valves AO 220-46 and 47

Moderator Temperature

Electrical Systems/Equipment Available:

o 'A' EDG Operating Feeding Bus A5.

o 'B' EDG Operating Feeding Bus A6.

Electrical Systems/Equipment Unavailable:

o Shutdown transformer due to blackout D.G. tie-in modifications.

o Start-up transformer.

o Unit auxiliary transformer.

o Switchyard Breakers 102, 103, 104 and 105 open.

o Switchyard Breaker 104 - stuck breaker trip (lockout).

Core Cooling Standby Systems Status:

o 'A' and 'C' RHR pumps in cooling.

o 'A' Core Spray secured in standby.

o 'B' Core Spray out of service due to suction valve shut.

Air Systems:

o K104-A, K104-C air compressors tagged out for maintenance.

o K104-B supplying instrument air (reduced pressure approximately 60 psig).

o K110, K111 air compressor motors de-energized.

The stuck breaker protective relaying for switchyard breaker 104 was cleared and reset at approximately 0831 hours on November 12, 1987. The clearing of the stuck breaker relaying allowed the other end of line #342 to be closed. At approximately 0954 hours, line #342 was energized.

The plan to restore Station power was formalized in a schedule about 1000 hours on November 12, 1987. The activities were ongoing and included washing the switchyard, restoration of the start-up transformer and preparations for backfeeding the site through the main transformer.

At approximately 1135 hours on November 12, 1987, the 'B' EDG was secured to correct an indication of zero amperes on the 'C' phase ammeter located in the EDG Breaker Cubicle.

When the 'B' EDG was secured, equipment powered from Bus A-6 was de-energized,

including the air compresor supplying Instrument Air (IA). As a result, valves A0220-46 and 47 shut, which were providing a vent path for the reactor vessel. The plant conditions at 1200 hours on November 12, 1987, were:

Mode Switch REFUEL

Reactor vented through one open manual vent valve

Reactor coolant Temperature

Electrical Systems/Equipment Available:

o 'A' EDG Feeding Bus A5.

Electrical Systems/Equipment Unavailable:

o Shut down transformer due to blackout D.G. modifications.

o 'B' EDG and Bus A6 - ('B' EDG secured at 1135 by Operations Supervisor to repair loss 'C' phase indication).

o Startup transformer.

o Unit auxiliary transformer.

o Switchyard Breakers 102, 103, 104 and 105 open.

Core Cooling Standby System Status:

o All RHR pumps secured (shut down cooling isolation valves MO1001-47 and 50 valves shut due to loss of 120 VAC Bus Y4 when the 'B' EDG was secured).

o 'A' Core Spray secured in standby.

o 'B' Core Spray out of service due to suction valve shut.

Air Systems:

o K104-A and C air compressors tagged out for Maintenance (K104-C repairs in progress).

o K104-B, power unavailable due to securing of 'B' EDG and K110, K111 unavailable due to loss of offsite power.

o Instrument air not available due to securing of 'B' EDG.

At 1205 hours on November 12, 1987, a second manual head vent was opened. At approximately 1235 hours the mode switch was placed in "SHUTDOWN". The Technical Support Center (TSC) was partially staffed at approximately 1300 hours to facilitate coordination of power restoration activities.

Washing of the switchyard from the terminals of the Bridgewater line #355 up to the startup transformer was completed at approximately 1330 hours on November 12, 1987. Power was restored to the line #342 and line #355, and breakers 102 and 103 were closed at approximately 1415 hours. At approximately 2000 hours, washing of the switchyard was completed.

The investigation of the 'B' EDG 'C' phase ammeter indication and repair of the watthour meter were completed at approximately 1630 hours. The problem was the result of a burned lug on a wire in the current transformer circuit to the watthour meter.

Power was reestablished to Bus A6 and selected loads at approximately 2309 hours on November 12, 1987, by a backfeed through the main/unit auxiliary transformer via Breaker 105. Bus restoration was completed at approximately 0007 hours on November 13, 1987. The scram signal was reset at approximately 0100 hours on November 13, 1987. Plant conditions at 0100 on November 13, 1987 were:

Mode Switch SHUTDOWN

Reactor vented via 2 manual valves

Reactor coolant temperature

Electrical Systems/Equipment Available:

o 'A' EDG feeding Bus A5.

o Unit AUX transformer feeding Bus A6 and Station house loads via backfeed - switchyard Breakers 102, 103, 105 closed.

Electrical Systems/Equipment Unavailable:

o Shut down transformer due to the new blackout D.G. modifications.

o Start up transformer awaiting completion of megger and high potential

(Doble) testing.

o Switchyard Breaker 104 open.

o 'A' Core Spray pump secured in standby.

o 'B' Core Spray pump out of service due to suction valve maintenance.

Air Systems:

o K111 supplying instrument air (repressurized at 2344 hours on November 12, 1987).

o K104-A and C tagged for maintenance.

o K110, K104-B operable.

At approximately 0600 on November 13, 1987, it was identified that the pre-lube pump on the B Emergency Diesel Generator would not rotate. The pump was replaced by approximately 1750 hours and the 'B' EDG was started at approximately 2003 hours. Fuel injector leaks were identified and the unit was secured to correct the leaks.

By 0255 hours on November 14, 1987, offsite power was transferred from the unit auxiliary transformer (backfeed) to the startup transformer, thereby restoring normal power feed to both the "A" and "B" train nuclear service buses (A5 and A6 respectively).

The "A" Diesel Generator was stopped at 0320 hours on November 14, 1987 having remained OPERABLE throughout the loss of offsite power.

The "B" Diesel Generator was returned to OPERABLE status at 2315 hours on November 14, 1987, following maintenance activities to replace the pre-lube pump and to repair fuel injector leaks.

ROOT CAUSES

The cause of the loss of preferred offsite power was a series of storm related faults in the power transmission system remote from the Pilgrim Nuclear Power Station. The observed condition of excessive ice and snow accumulation on the transmission system combined with high winds resulted in a fault on the 345 KV grid. At the time of this event, the secondary offsite power source was unavailable due to the prior removal of the shutdown transformer from service to permit the installation of the "blackout" diesel generator.

The apparent cause for the blown fuses in the RPS Analog Trip System (ATS) cabinets was high inrush current when energizing and de-energizing the ATS cabinets. The apparent root cause appears to be improper type/size fuses being used on this system.

The cause of the zero reading on the Phase C ammeter on the 'B' EDG was an open circuit on terminal #8 of the 'B' EDG watthour meter. The open electrical circuit resulted when the connection between the lug and wire, burned and separated. The most probable cause was a less than adequate lug-to-wire crimp. With time, the wire loosened from the lug, causing high resistance heat buildup and probable high voltage arcing at the wire to lug connection. The resulting heat buildup caused the wire to burn free from the lug.

Investigation into the cause of the 'B' EDG pre-lube pump failure identified a small piece of metal fused to the pump idler in a tight clearance area of the pump. The rotor and casing backing plate were observed to be scored. The identified piece of metal is believed to have come from the pump rotor which showed signs of wear. Two days prior to the pump failure, two (2) bolts were found to be loose, one on the pump casing and one on the pump backing plate. On November 10, 1987, the bolts were tightened. The pre-lube pump continued running during and subsequent to tightening of the loose bolts. The casing backing plate of the pump housing has a normal clearance of .003"-.005" when tightened. Based on discussions with the manufacturer, it was determined that when the pump mounting bolts become loose the pump is subject to accelerated internal wear. It is believed that the piece of metal was located in the clearance area between the idler and backing plate prior to tightening of the loose bolts. Once the pre-lube pump stopped rotating, due to the loss of offsite power and subsequent automatic diesel start, it would not restart (rotate) again when energized. The failed pump is a Viking Model HJ475M, Serial No. 2349299.

Investigation into the apparent slow opening of ACB No. 104, that resulted in the actuation of the "stuck breaker" protection logic, could not establish the root cause. Subsequent testing of ACB No. 104 for overall breaker timing and timing of the main contacts did not identify any contributing component malfunction or failure. Additional testing of protective relay timing circuits indicated a reduction of 27 percent (75 to 55 milliseconds) in the delay time before the "stuck breaker" logic is initiated. Although this reduction alone does not fully account for the "stuck breaker" actuation, a properly set (75 milliseconds) timing relay may have prevented this actuation. The delay time setpoint was reset to 75 miliseconds. Severe weather conditions at the time of the event could have been a contributing

factor, but these conditions do not explain the random occurrence of "stuck breaker" logic actuation associated with other related events at PNPS.

IMMEDIATE CORRECTIVE ACTION

Immediate corrective action was the automatic start of the onsite nuclear service diesel generators, which served to reestablish electrical power to the safety related components. Switchyard insulator washing, resetting of lock out relays, startup transformer testing and providing power via a backfeed of the unit auxiliary transformer were performed in parallel. Essential loads were powered via the auxiliary transformer by 2309 on November 12, 1987. In addition an air compressor was obtained as a precautionary measure, but was not used with the instrument air system.

After the 'B' Diesel Generator was removed from service, action was taken immediately to determine the cause of the 'C' phase ammeter zero reading. The zero reading was determined to be due to an open circuit in the 'B' Diesel Generator watthour meter at panel C8. Maintenance Request 87-730 was written and the terminal was relugged.

The corrective action for the lube oil circulating pump failure to start was to replace the pump and motor on November 13, 1987.

Ultimately, offsite power was restored to both nuclear service busses via the startup transformer by 0255 on November 14, 1987. The 'B' Diesel Generator was restored to OPERABLE status at 2315 hours November 14, 1987.

LONG TERM CORRECTIVE ACTIONS

A plant modification is currently in progress to install a "blackout" diesel generator. The completion of this modification will improve the reliability of onsite power supplies and will minimize the significance of a loss of offsite power.

To improve the reliability of the Instrument Air System, an additional back-up air supply will be installed.

Additionally, plant modifications are currently in progress to provide additional instrumentation to monitor conditions in the switchyard. Completion of these modifications will provide a more timely assessment of switchyard problems to aid in restoration of power in the event of a loss.

Procedure 8.9.9 is being revised to facilitate a more timely backfeeding of

the unit auxiliary transformer.

An evaluation of the startup transformer differential relays (HU-1 relays) susceptability to lock out on EMF during motor coast downs is in progress. The purpose of the evaluation is to eventually provide the capability of a more timely diagnosis and restoration (e.g., eliminate time consuming testing that would be necessary to confirm transformer adequacy after differential relay operation).

A test (TP87-259) will be performed to determine the amplitude and duration of the inrush current that energizing and de-energizing the ATS Cabinets will produce. Shoul
the test demonstrate that the fuses were in fact properly
sized, a supplement to this report will be provided.

Additionally, recommendations for administrative and technical improvements are being reviewed for feasibility of implementation and are not described in this LER.

SAFETY SIGNIFICANCE OF THE LOSS OF OFFSITE POWER

The safety significance of this loss of offsite power was minimal due to the automatic start of the 'A' and 'B' diesel generators. Due to the neglible core decay heat levels, reactor coolant temperatures remained stable during the temporary loss of shutdown cooling. All control rods were fully inserted and the plant remained in a cold and stable shutdown condition.

Had this event occurred while the plant was operating, the ADS, HPCI system and RCIC system would have been available to control reactor water level and pressure initially. As the reactor depressurized, core spray and RHR would be available to maintain reactor water level and remove decay heat.

SIMILAR EVENTS

Similar losses of offsite power due to transmission line faults are:

LER 78-002 - Shielding Mast Fell Across 345 KV Lines

LER 78-003 - Severe Weather

LER 79-027 - Lightning Strike

LER 79-033 - Lightning Strike

LER 83-045 - Lightning Strike

LER 86-027 - Severe Winter Weather

LER 87-005 - Severe Weather In Conjunction With Switchyard Work In Progress

ENERGY INDUSTRY IDENTIFICATION SYSTEM (EIIS) CODES

The EIIS codes for this event are:

SYSTEM CODE

Reactor Protection System JC
Medium Voltage Power System EA
Emergency Onsite Power Systems EK
Diesel Lube Oil System LA

COMPONENTS CODE

Fuse FU
Relay RLY (87)
Indicator, Current II
Pump P

FIGURE OMITTED - NOT KEYABLE (DRAWING)

10CFR50.73

BOSTON EDISON
Executive Offices
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Boston, Massachusetts 02199

Ralph G. Bird
Senior Vice President - Nuclear

December 23, 1987
BECo Ltr. #87-204

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Docket No. 50-293
License No. DPR-35

Dear Sir:

The attached Licensee Event Report (LER) 87-014-01 "Loss of Offsite Power" is submitted in accordance with 10CFR50.73.

Please do not hesitate to contact me if you have any questions regarding this subject.

/s/ R. G. Bird
R. G. Bird

Enclosure: LER 87-014-01

cc: Mr. William Russell
Regional Administrator
Region I
U.S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, PA 19406

Sr. Resident Inspector - Pilgrim Station

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